Pub. 11P-24 5

ELECTROSURGERY

A BRIEF REVIEW OF ITS ADVENT AND SOME OF ITS USES

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Reprinted from
The Journal of the American Medical Association
February 20, 1932, Vol. 98, No. 8

American Medical Association
535 North Dearborn Street
Chicago

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Electrosurgery came on the surgical horizon about 1907 as an outcome of the epoch making experiments of d'Arsonval and Oudin. The present efficient form of electrosurgery in this country, and largely in the world, is due to William L. Clark of Philadelphia, who took it over in a crude state and brought it to the borders of perfection. Addenda have been large due to technical developments by electrical specialists, responding to stated needs of surgeons.

De Keating Hart and Pozzi over twenty years ago used a long sparking current of high voltage and low amperage for the destruction of tumors, called fulguration Edwin Beer[1] of New York took this up about 1908 and used it extensively in bladder tumors. The difficulty with this agent was a lack of penetration; Beer's work, however, was distinctly prophetic of all that has followed.

The demand for electrosurgery arose from imperfections in the established surgical technic, long accepted as inherent in operative methods and, therefore, hardly realized until the new agent and the acquired facility necessary to its skilful application appeared to remedy them.

The reproaches indicated have lain in the prolongation of operations due to the application of ligatures to stop hemorrhage; in the liability of conveying infection or of distributing it in the general course of many operations; in the fact that ligatures acting as foreign bodies may become foci of infection; in the deplorable manipulations of tissues; in the contamination of wounds and general messiness of handling malignant growths and chronic and subacute infections; in the limitations often imposed on our extirpative work by reason of the depth of the operation from the surface, particularly in the oral and nasal cavities, in neural surgery, and in rectal and sometimes in abdominal procedures; in the fact that any serious difficulty of ligation in sharp hemorrhage in a deep operation often precludes a satisfactory continuation to its completion; in the condition of tissues after recovery, which makes a desirable secondary operation objectionable; in shock arising from prolonged operation with attendant hemorrhage. Experience has shown that these objections are in a measure overcome by electrosurgery.

Electrosurgery as now used is the employment of a high frequency alternating electric current of about 1,000,000 to 2,000,000 or more oscillations per second for the destruction or excision of diseased tissues. The current voltage and amperage under perfect control ranges from a minute, almost invisible, spark up to a heavy flashing flame, causing a necrobiotic heat penetration to the depth of 1 cm. on all sides of the electrode. The current is applied by "active" electrodes of various shapes: needle, thin narrow blade, ball, curet, wire loop.

These currents are applied through a uniterminal or biterminal connection with the generating apparatus, affording either a desiccation or a dehydration of the tissues, an electrocoagulation, or, by molecular disintegration, a cleavage or cutting of tissues.

The cardinal virtues of electrosurgery lie in effective destruction in loco of tissues that it is desirable to eliminate. This manifestly includes all forms of malignancy. There is no handling of tissues because of the knife and fork type of operation, which is unequaled in cleanliness by the immediate complete sterilization of both bacterial and malignant infection.

Hemostasis is easily effected in severing vessels up to about 1 mm. in diameter either by the application of the coagulating electrode direct or by the intermediary of a well-pointed hemostatic clamp, isolating the vessel. Thus ligatures are avoided, and the risk of infection is lessened by reason of the reduction of the imported foreign material. The ability to check hemorrhage, keeping the fingers away from the wound, makes it possible to continue deep work in various parts of the body.

Another advantage is the extended use of local anesthesia, which reduces hospitalization by making a number of these patients ambulatory.

A notable achievement lies in the group of operations being undertaken, many of them until recently hardly possible, particularly extensive malignant growths of the jaw, oral cavity, antra, brain, breast, thyroid, and vulva, resulting in a great number of patients with open wounds which, being kept clean, heal rapidly without pain or toxemia and yield a soft, pliable scar. Tonsillectomies in patients presenting contraindications for ordinary surgical procedure, such as cardiac disease and advanced age, are now being performed electrosurgically by trained operators. The destruction of the tonsil is effected in several stages, by applying the current alternately first to one side and then to the other, at intervals of one or two weeks. Such patients are usually ambulatory. The pillars must be kept from adhering by scar tissue until all infection disappears, thus avoiding encapsulation of infectious material. The method is still considered to be applicable only in selected cases and by men especially trained both in electrotherapy and otolaryngology.

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[1] Beer, Edwin: Removal of Neoplasms of the Urinary Bladder, J. A. M. A. 54: 1768 (May 28) 1910.

Those unfamiliar with the intensity of the high frequency currents and their depth of penetration may easily strike destruction into deep-seated structures adjacent to the disease areas. Especially is this true of blood vessels (a carotid, for example) leading to and from the part or traversing neighboring tissues. To prevent hemorrhage at the operation or subsequently when the coagulum sloughs away, a ligation of tributary vessels is often advisable. While muscles (the pectoral, for example) are being incised, the faradic effect may be sufficient to cause muscular jerkings lively enough to throw the electrode against a neighboring large vessel. Severance of nerves often causes the same muscular contraction in the muscles supplied, with dangerous possibilities.

Another pitfall is that of undertreatment, particularly in the hands of an amateur. The extreme limits of the disease must always be estimated in malignant conditions and the destruction and the extirpation carried well out into the normal zone. The electrosurgical aspirant should first acquire a good general surgical training, adding later to his technic the use of the high frequency electric currents. A mere novice has no more right to exploit this new adjuvant than has the first year medical student to prescribe digitalis.

Various forms of apparatus have been developed through the years to such an extent that at present the market is replete with many new instruments, some of them only fairly satisfactory. Research jointly by surgeon and physicist, together with the competitive spirit of a group of able manufacturers continually improving their products, has accomplished much in developing a number of admirable, perfect instruments. Two general types are available: The one, dating from the original experiments of d'Arsonval and others, employs a transformer, a series of condensers, spark gaps and an Oudin coil as the source of power; the other, beginning with the discoveries of de Forest, employs one or more triode vacuum tubes as the generating factor. Each surgeon will learn to choose for himself, after thorough trial, the type best adapted to his needs. The better machines furnish a current readily available by the easy manipulation of a comprehensible switchboard or the ready change of electrodes.

The perfect generator should produce a smooth current without faradic effect, varying from the finest desiccation spark to heavy coagulation without much flashing or uncontrollable flame. Efficient coagulation by a blunt or ball electrode brought near to the tissues, with the minimal visible sparking, is another criterion of a perfect current. There ought not to be any fusion of coagulated tissues to the electrode, but to date no material is available out of which electrodes can be made which will not stick to the tissues, pulling some away when removed and risking tearing a vessel. In addition, the cutting current should be regulable from one severing tissue with only 0.1 mm. of destruction on each side to one coagulating 1 or 2 mm. in depth. The fine cutting current permits primary union; the heavier cutting current used in excising an extensive ulcerative malignant growth leaves in situ a dry sterile coagulum, which prevents any local recurrence or the dissemination of cells spilled from the ulcer. In the latter class, the local defects are so great that primary union is not anticipated and the coagulum becomes a desideratum. All these features, characterizing the perfect machine with the minimum number of controls, should be available at the operating table through a proper foot switch or by sterile connections for the operator's immediate control, without calling for an extra assistant.

At present, electrosurgical cutting and coagulation are accomplished by separate electrodes, usually of different shape, either necessitating two connections with the machine or an interchange of electrodes in a common handle attached by a single wire to the apparatus. In the latter instance an extra assistant is needed to switch from cutting to coagulating current or vice versa. Two wires, used to carry the current, form an awkward addendum at an already complicated operating table. In operating rooms, where inflammable anesthetics are used, surgeons are urged to secure apparatus of the best construction and to keep it in good repair, because open or static electric sparks may cause serious explosions.[2] As time passes, it is hoped that these and other technical problems will be simplified.

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[2] Death from Explosion of Anesthetic Gases, editorial, J. A. M. A. **96**: 530 (Feb. 13) 1932.

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Printed in U. S. A.